PCT/JP2004/014688

29. 9. 2004

日本国特許庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office.

REC'D 21 OCT 2004
WIPO PCT

出願年月日
Date of Application: ２００３年１０月１６日

出願番号
Application Number: 特願２００３－３５６９３６

[ST. 10/C] : [ＪＰ２００３－３５６９３６]

出願人
Applicant(s): 日本電気株式会社

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH
RULE 17.1(a) OR (b)

２００４年　８月　４日

特許庁長官
Commissioner,
Japan Patent Office

小川洋

出証番号　出証特２００４－３０６８９６３

【書類名】　特許願
【整理番号】　49200442
【特記事項】　特許法第３６条の２第１項の規定による特許出願
【提出日】　平成15年10月16日
【あて先】　特許庁長官殿
【国際特許分類】　H04B　7/26
【発明者】
　【住所又は居所】　東京都港区芝五丁目７番１号　日本電気株式会社内
　【氏名】　リー　ジンソック
【特許出願人】
　【識別番号】　000004237
　【氏名又は名称】　日本電気株式会社
【代理人】
　【識別番号】　100071272
　【弁理士】
　【氏名又は名称】　後藤　洋介
【選任した代理人】
　【識別番号】　100077838
　【弁理士】
　【氏名又は名称】　池田　憲保
【手数料の表示】
　【予納台帳番号】　012416
　【納付金額】　35,000円
【提出物件の目録】
　【物件名】　外国語特許請求の範囲　1
　【物件名】　外国語明細書　1
　【物件名】　外国語図面　1
　【物件名】　外国語要約書　1
　【包括委任状番号】　0018587

【書類名】外国語特許請求の範囲

1. A method for maintaining closed loop capacity scheduling between a base station and a mobile station, the method comprising the steps of:

associating each flow with a Flow Capacity Controller (FCC) in the mobile station; and

selecting a traffic class as a selected traffic class from a plurality of QoS traffic classes which are prepared in the mobile station and which are different from one another; and

assigning a priority to each flow at the mobile station in consideration of the selected traffic class so as to carry out transmission of the different QoS traffic classes.

2. A method as claimed in claim 1, further comprising the step of:

calculating, by the FCC of the mobile station, an uplink capacity of each flow based on the selected traffic class.

3. A method as claimed in claim 2, further comprising the steps of:

modifying a capacity request of each flow by a Capacity Request Controller (CRC) by using the priority, the selected traffic class, and a uplink transmission power; and

transmitting a modified capacity request of each flow from the mobile station to the base station.

4. A method as claimed in claim 3, further comprising the steps of:

receiving the modified capacity request at the base station;

calculating an allowable capacity for each flow by a Capacity Scheduler

(CS) at the base station by the use of the modified capacity request; and

transmitting a capacity assignment representative of the allowable capacity of each flow from the base station to the mobile station.

5. A method as claimed in claim 4, further comprising the steps of:

receiving the capacity assignment by a Capacity Assignment Controller (CAC) at the mobile station;

modifying the received capacity assignment at the CAC, by the use of the selected traffic class and a uplink transmission power, into a modified assigned capacity; and

updating the allowable capacity at the FCC by using the modified assigned capacity.

6. A system for maintaining a closed loop capacity scheduling between a mobile station and a base station, the mobile station being selectively operable in accordance with a plurality of QoS traffic classes and comprising:

a Flow Capacity Controller (FCC) for calculating a required uplink capacity of each data flow specified by a selected QoS traffic class;

a Capacity Request Controller (CRC) for modifying the required uplink capacity to produce a modified capacity request representative of the modified capacity; and

means for transmitting the modified capacity request from the mobile station to the base station.

7. A system as claimed in claim 6, wherein the mobile station further comprises:

a Capacity Assignment Controller (CAC), responsive to a capacity

assignment sent from the base station, for modifying a received assigned capacity on the basis of the uplink transmission power ;

the FCC updating an allowed capacity by the use of the modified assigned capacity.

8. A system as claimed in claim 6 or 7, wherein the base station comprises:

receiving means for receiving the modified capacity request; and

a Capacity Scheduler for calculating an allowable capacity for each flow by using the selected traffic class, priority, and the modified capacity request sent from the mobile station.

9. A method of managing an uplink capacity at a base station for a plurality of uplink data flows, comprising the steps of:

estimating, at the base station, a schedulable uplink capacity which is represented by a difference between a maximum uplink capacity and a non-schedulable uplink capacity;

receiving a capacity request sent from a mobile station;

calculating a minimum QoS capacity for each flow on the basis of a priority assigned to each flow to fulfill minimum QoS requirements; and

assigning the minimum QoS to each flow.

10. A method as claimed in claim 9, further comprising the steps of:

calculating an additional request capacity for each flow to fulfill a maximum utilization of a left-over uplink capacity that is an available schedulable capacity after allocation of the minimum QoS capacity; and

assigning a left-over capacity to each flow having the additional request capacity.

【書類名】外国語明細書

1. Title of Invention

Provision of multiple QoS and multiple priorities for uplink packet data scheduling

2. Detailed Description of Invention

[Field of the Invention]

The present invention relates to data packet transmission rates, and more particularly, to a closed-loop capacity scheduling method for uplink packet transmissions from a mobile phone to a base station. Especially, the present invention also relates to improvement of Wideband Code Division Multiple Access (W-CDMA).

A capacity scheduling scheme at base station (called High-Speed Downlink Packet Access (HSDPA)) was adopted as the Release 5 of 3GPP (3rd Generation Partnership Project) Standard. It is based on the fast capacity control of downlink packet transmission that aims to maximize the multiple user diversity. Similar to HSDPA, a capacity scheduling scheme at base station has been also actively studied, namely, Enhance Uplink Dedicated Channel (EDCH).

The present invention also relates to provision of multiple QoS and multiple priorities in the uplink data packet transmission. Provision of multiple QoS and priorities is a key requirement in the uplink packet transmission enabling service differentiation of packet data applications. This invention considers QoS aware data packet scheduler which support distinct traffic classes, such as Guaranteed Bit-rate (GBR), Target Bit-rate (TBR)and Available Bit-rate (ABR).

[Background of the Invention]

In WCDMA system, the uplink capacity of a cell is managed in a distributed way that a mobile station can transmit up to maximum capacity that is controlled by a Radio Network Controller. The uplink noise rise management is based on slow statistical multiplexing that the radio network controller controls the maximum rate of transmissions of mobile stations. This would result in the high noise rise variation that could lead to a loss of uplink capacity due to large noise rise headroom. Furthermore the priority handling of WCDMA is such that higher priority data packets are transmitted prior to lower priority data packets.

As a sister technology of HSDPA, a closed-loop-based capacity scheduling is recently proposed in 3GPP. Reference is a technical report TR 25.896 v1.0.0, 'Feasibility Study for Enhanced Uplink for UTRA FDD'. Uplink Capacity Scheduling is currently under study in Enhanced Uplink R6 Study Item. In this item, a fast uplink rate scheduling is employed at base station and it controls the mobile station packet transmission in such a way that the noise rise variation of cell reduces by restricting mobile station sending packets at the same time. To manage the total noise rise, the capacity scheduler controls the power, rate and timing of uplink transmission of the mobile stations.

[Disclosure of the Invention]

[Problems to be solved by the Invention]

As illustrated in Fig. 1, a base station 13 controls the uplink transmission capacity of mobile stations 11 and 12 by exchanging capacity request 110 in uplink and capacity assignment 120 in downlink. Capacity scheduling is that the transmission rate and transmission period is controlled for the mobile station transmitting data packet using the shared uplink capacity 14. Scheduling instance 140 is the time when the decision of capacity scheduling is being made and the decision is valid until the next scheduling instance. The mobile stations carry out transmission in a portion of time within scheduling interval at an allowed transmission rate.

It is a first object of this invention to provide the capacity scheduling which can maximize the system capacity by restricting the total uplink noise rise.

In the uplink packet scheduling, it is essential to support means to distinguish the packet transmission based on their traffic class. For example, consideration is made about the mobile station 1 that uses a streaming service with GBR traffic class 11 in Fig. 1, requiring a minimum guaranteed capacity whereas mobile station 2 uses a best effort service with ABR traffic class 12 in Fig. 1, having no explicit QoS requirement.

When these two QoS traffic classes co-exist in the cell, the capacity scheduler 13 should efficiently utilize the uplink capacity in such a way that QoS of individual traffic class is met while the system throughput is maximized.

It is a second object of this invention to provide multiple QoS packet transmission.

In the uplink packet scheduling, it is also essential to support means to distinguish the packet transmission based on their priority class. For example, it is assumed that business user 11 in Fig. 1 with premium subscription should be treated with a higher priority than home user 12 with economic subscription. When these multiple priorities co-exist in the network, the capacity should be efficiently utilized in such a way that capacity is allocated to higher priority packet transmission, prior to lower priority packet transmission.

The third object of this invention is to provide multiple priority packet transmission.

In the uplink packet scheduling, it is also essential to support means to multiplex multiple data packet transmission. For example, user of mobile station 1 '11' in Fig. 1 may download files from the Internet while he is communicating with his colleague using streaming service. Each data packet transmission has distinct traffic class and priority so that there are multiple QoS and multiple priority data packet transmission co-exist in the

network. The capacity should be allocated in such a way that individual QoS of each data packet transmission is met as well as the capacity scheduling'13' in Fig. 1 differentiates the transmissions based on the priority.

The fourth object of this invention is to provide multiple QoS and multiple priority packet transmission.

In the uplink packet scheduling, the capacity of radio resource can be efficiently utilized if the capacity scheduling is fast enough to track the change of wireless channel environment. This can be achieved by the scheduling being carried out closer to radio channel at the base station and mobile station. The capacity improvement should then be achieved by leveling out the fast change of uplink noise rise so that smaller noise rise margin is required for uplink packet transmission. The uplink packet scheduling at the base station should then take into account the multiple QoS and multiple Priority of data packets co-existing in the network while maintaining higher system throughput.

The fifth object of this invention is to provide the capacity scheduling which maximize the system capacity while supporting multiple QoS and multiple priorities.

[Means for solving the Problems]

According to a first aspect of this invention, a method is for maintaining closed loop capacity scheduling between a base station and a mobile station. The method comprises the steps of associating each flow with a Flow Capacity Controller (FCC) in the mobile station, selecting a traffic class as a selected traffic class from a plurality of QoS traffic classes which are prepared in the mobile station and which are different from one another, and assigning a priority to each flow at the mobile station in consideration of the selected traffic class so as to carry out transmission of the different QoS traffic classes.

According to a second aspect of this invention, the method comprises the step of calculating, by the FCC of the mobile station, an uplink capacity

of each flow based on the selected traffic class.

According to a third aspect of this invention, the method further comprises the steps of modifying a capacity request of each flow by a Capacity Request Controller (CRC) by using the priority, the selected traffic class, and a uplink transmission power and transmitting a modified capacity request of each flow from the mobile station to the base station.

According to a fourth aspect of this invention, the method further comprises the steps of receiving the modified capacity request at the base station, calculating an allowable capacity for each flow by a Capacity Scheduler (CS) at the base station by the use of the modified capacity request, and transmitting a capacity assignment representative of the allowable capacity of each flow from the base station to the mobile station.

According to a fifth aspect of this invention, the method further comprises the steps of receiving the capacity assignment by a Capacity Assignment Controller (CAC) at the mobile station, modifying the received capacity assignment at the CAC, by the use of the selected traffic class and a uplink transmission power, into a modified assigned capacity, and updating the allowable capacity at the FCC by using the modified assigned capacity.

According to a sixth aspect of this invention, a system is for maintaining a closed loop capacity scheduling between a mobile station and a base station. The mobile station is selectively operable in accordance with a plurality of QoS traffic classes and comprises a Flow Capacity Controller (FCC) for calculating a required uplink capacity of each data flow specified by a selected QoS traffic class, a Capacity Request Controller (CRC) for modifying the required uplink capacity to produce a modified capacity request representative of the modified capacity, and means for transmitting the modified capacity request from the mobile station to the base station.

According to a seventh aspect of this invention, the mobile station further comprises a Capacity Assignment Controller (CAC), responsive to a capacity assignment sent from the base station, for modifying a received assigned capacity on the basis of the uplink transmission power, the FCC

updating an allowed capacity by the use of the modified assigned capacity.

According to an eighth aspect of this invention, the base station comprises receiving means for receiving the modified capacity request and a Capacity Scheduler for calculating an allowable capacity for each flow by using the selected traffic class, priority, and the modified capacity request sent from the mobile station.

According to a ninth aspect of this invention, a method is for use in managing an uplink capacity at a base station for a plurality of uplink data flows. The method comprises the steps of estimating, at the base station, a schedulable uplink capacity which is represented by a difference between a maximum uplink capacity and a non-schedulable uplink capacity, receiving a capacity request sent from a mobile station, calculating a minimum QoS capacity for each flow on the basis of a priority assigned to each flow to fulfill minimum QoS requirements, and assigning the minimum QoS to each flow.

According to a tenth aspect of this invention, the method further comprises the steps of calculating an additional request capacity for each flow to fulfill a maximum utilization of a left-over uplink capacity that is an available schedulable capacity after allocation of the minimum QoS capacity and assigning a left-over capacity to each flow having the additional request capacity.

According to a specific aspect of this invention, a method is for maintaining closed loop capacity scheduling between a base station and a plurality of mobile station. The method comprises the steps of:

1: associating each flow with a Flow Capacity Controller (FCC) depending on traffic class of each flow and assigning a priority and an initial value of capacity to each flow in the set at the mobile station;

2: storing, in the mobile station, a data packet which belongs to a data flow of the set into the associated data packet queue;

3: calculating, in the Flow Capacity Controller at the mobile station, the required uplink capacity of the data flow based on the required quality of service of the flow;

4: modifying, in Capacity Request Controller (CRC), the capacity requests of data flows of the said set using the associated priorities and transmitting the modified capacity requests from the mobile station to the base station;

5: receiving the capacity requests sent by the said plurality of mobile stations at the base station and calculating retransmission data packet after receiving the data packets sent by the said plurality of mobile stations;

6: calculating for each flow, by a Capacity Scheduler at the base station, the allowable capacity using associated QoS traffic class, priority and the sent capacity request;

7: transmitting the capacity assignment from the base station and modifying, in Capacity Assignment Controller, the received assigned capacity of data flows of the set using the associated priorities; and

8: updating, in the Flow Capacity Controllers, the allowed capacity using the modified assigned capacity of data flows of the set.

According to another specific aspect of this invention, a sub-system is used in a system of managing the uplink capacity for scheduling the uplink capacity at a base station for a plurality of uplink data flows. The system is operable in accordance with a method comprising the steps of:

1: estimating a schedulable uplink capacity, at the base station, which is a difference from a maximum uplink capacity and a non-schedulable uplink capacity;

2: receiving and handling the capacity request in the manner mentioned above;

3: calculating and assigning a required packet retransmission capacity from a reception status of previous data packet transmission(preferably, the mobile stations keep the retransmission probability low);

4: calculating minimum QoS capacity for the flows in the said set to fulfill minimum QoS requirements (specifically, for GBR, ABR and TBR traffic, the Guaranteed Capacity, Minimum Capacity and requested capacity are the minimum QoS capacity, respectively;

5:assigning minimum QoS capacity to the flows in the said set based on its associated priority. Higher priority flow is assigned the capacity prior to lower priority flow.

6: calculating additional request capacity for the flows in the said set to fulfill the maximum utilization of left-over uplink capacity that is available schedulable capacity after allocating retransmission and minimum QoS capacity (especially, for GBR and ABR traffic, the capacities above Guaranteed Capacity and Minimum Capacity are additional request capacity);

7. assigning left-over capacity to the flows having additional request capacity in the said set based on its associated priority (specifically, higher priority flow is assigned the capacity prior to lower priority flow. Preferably, each priority set is assigned a ratio of left-over capacity);

8. calculating total capacity for each flow using retransmission, minimum QoS and left-over capacity and transmitting to mobile stations.

According to still another aspect of this invention, a method is for use in managing the uplink capacity flow capacity control, at the mobile station. The method comprises the steps of:

1. assigning QoS Parameters of each flow of the said set using its traffic class (Preferably, the QoS traffic class includes Guaranteed Bit-rate, Target Bit-rate and Available Bit-rate. Preferably, the required QoS parameter includes a Maximum Capacity, Minimum Capacity, Target Capacity and Guaranteed Capacity);

2. calculating the retransmission capacity of each flow in the said set;

3. calculating required capacity for new data packet transmission to fulfill the associated QoS requirements; and

4. calculating a Capacity Request for uplink Capacity Scheduler.

According to yet another aspect of this invention, a method is for use in signaling the capacity request and assignment message and comprises in steps of:

1. forming the Capacity Request Message including the Capacity Request of the flows in the said set and the flow identification (Preferably, the Capacity Request Message is encoded at the mobile station and decoded at the base station);

2. transmitting the Capacity Request Messages from the mobile stations and receiving at the base station (Preferably, the Capacity Request Message is transmitted via a dedicated uplink channel);

3. forming the Capacity Assignment Message including Capacity Assignment of the flows in the set and the flow identification (Preferably, the Capacity Assignment Message is encoded at the base station and decoded at the mobile stations);and

4. transmitting the Capacity Assignment Message from the base station and receiving at the said mobile stations (Preferably, the Capacity Assignment Message is transmitted via a dedicated downlink control channel).

[Merits of Invention]

The first benefit of present invention is QoS and Priority aware uplink capacity scheduling at the base station. Compared to WCDMA system where the capacity of uplink data flow is loosely controlled by means of controlled maximum capacity of mobile station, this invention enables both the priority and QoS of data flow is handled by the base station which is aware of both QoS and priority of flows.

In addition, the second benefit of this invention is that both the mobile and base station are aware of QoS of data flow in addition to the priority. Current rate assignment policy in WCDMA is that only priority

of data flow is considered in distributing the uplink capacity among the multiple uplink data flows. The present invention allows a split of requested flow capacity into minimum QoS and left-over capacity so that it enables minimum QoS capacity of low priority data flow is guaranteed prior to excessive QoS of high priority data flow.

In addition, the third benefit of this invention is mobile station being able to adjust the capacity request and assignment considering QoS and priority of data flows. The adjustment of capacity request is essential when a sum of requested capacities cannot be met at given uplink transmission power. Also the adjustment of capacity assignment is required due to the scheduling delay. In this invention, a QoS and priority aware adjustment is proposed and it enables left-over capacity of lower priority flow is adjusted prior to the minimum QoS capacity of higher priority flow.

[Best mode for practicing the Invention]

[Embodiments]

The present invention is for maintaining a closed loop uplink capacity scheduling in a cell. Fig. 2 illustrates a system comprising a plurality of mobile stations and a base station in addition to the uplink and downlink channel structure. The entities which belong to the mobile station are a flow capacity controller (FCC), Capacity Request Controller (CRC), flow queue, TFC controller (TFCC), flow multiplexer (FMUX),and encoder (ENC). The entities which belong to the base station are a capacity scheduler(CS), decoder (DEC), flow demultiplexer (FDEMUX), and flow queues.

At the mobile station, an uplink data flow queue 211 in Fig. 2 stores the data packet to be sent on uplink. A flow queue is always associated to a flow capacity controller (FCC) 212 which knows the QoS parameters, unique identification number and the queue size of the associated flow queue.

At the establishment of new data flow, the radio network controller preferably sets the initial capacity and the initial capacity is signaled to the associated FCC. The FCC calculates the required uplink capacity of the associated data flow based on the required QoS of the flow and it generates Capacity Request (CR) which is then forwarded to Capacity Request Controller (CRC) 213. The CRC examines the current available transmission power headroom 2130 in Fig. 2 and calculates a supportable total uplink capacity.

If the total amount of capacity request from FCC attached to CRC is higher than the supportable uplink capacity, then CRC reduces the CR staring from the lowest priority flow to the highest priority flow. After CRC multiplexes the CR and transmits CRM to the uplink capacity scheduler located at the base station [221]. The scheduler decision is then sent to the mobile station as Capacity Assignment Message (CAM) indicating the allowable uplink capacity for each data flow. The CAM are received by Capacity Assignment Controller (CAC)[214] and de-multiplexed into each FCC. CAC calculates a supportable uplink capacity based on the available transmission power headroom. If the total amount of received CAM is higher than a supportable uplink capacity, then CAC reduces the CAM starting from the lowest priority to the highest priority flow.

In this manner, each FCC performs independently a closed-loop of CRM and CAM handling with the Capacity Scheduler.

At the mobile station, the uplink data transmission is performed in the following manner: The TFC Controller(TFCC) 215 collects the flow capacity allocated for each data flows and then it calculates the transport format combination in such a way that each flow sends its data packets up to the allocated flow capacity. The TFCC 215 also send the TFCI (transport formation combination indicator) to the base station. Once TFCI is chosen, the data packets from flow queues are encoded by ENC216 and multiplexed by FMUX 217. Preferably, the TFCI is sent in uplink traffic channel in addition to the multiplexed data packets.

At the base station, the uplink data reception is performed in the following manner: The Flow De-Multiplexer (FDEMUX) 221 separates the received bit streams into separate sub bit streams which are then separately decoded by DEC 222. The successfully decoded data packets are then stored into the respective flow queues [223]. The DEC 222 reports the state of decoding of each data packets to Retransmission Controller(RETXC) [224] which then forwards the status to the uplink Capacity Scheduler 225.

At the base station, the CRM from mobile stations are received [226] and fed into the Capacity Scheduler(CS) 225. Then the CAM are generated by the CS 225 and transmitted to the mobile stations [227].

At the uplink control channels [241], the CRM are transmitted from the mobile stations to the base station. Each CRM includes the required capacity for the flow and the FID. Preferably, the CRM is encoded at the mobile station and decoded at the base station. Preferably, mobile station sends additional report of its current transmission power headroom. Preferably, each mobile station transmits a separate UL control channel.

At the downlink air interface [242], CAM are transmitted from the base station to the mobile stations. Each CAM includes the allowed capacity for the flow and the FID. Preferably, the CAM is encoded at the base station and decoded at the mobile station. Preferably, the base station sends a shared downlink control channel that is received by the mobile stations waiting for CAM.

A generalized structure of Flow Capacity Controller is shown in Fig. 3. Although detail implementation of this controller is dependent on the traffic class of the flow, this figure illustrates an essential procedure common to all traffic class. The FCC is performed at least at the same period as the scheduling interval 31 in Fig. 3. The input parameters of FCC are the currently Assigned Capacity (AC) for the flow, a Required Capacity for Retransmission (RCR) and associated QoS parameters with the flow. Preferably, each traffic class has a unique set of QoS parameters. The output parameters of FCC are, then, Allocation Capacity for Retransmission (ACRT), Allocated Capacity for New Transmission (ACNT) and Capacity Request (CR). Firstly, FCC

calculates the required capacity for retransmission to fulfill the packet data latency requirement 32 and 33 in Fig. 3. Preferably, the latency requirement is strict that FCC allocates as much as needed capacity to retransmission. Secondly, FCC calculates a required capacity for new data transmission containing both minimum QoS and excessive QoS capacity of the flow 340, 341 and 35 in Fig. 3. The Left-Over Capacity (LOL) 360 in Fig. 3 is the difference between AC and a sum of ACRT and ACNT. Finally, the CR is calculated whether more capacity is needed or not for next scheduling interval.

The GBR is a traffic class of which capacity is guaranteed up to pre-define level by the scheduler. The QoS parameters of GBR traffic class are the Maximum Capacity (MC) and the Guaranteed Capacity (GC). MC is the upper limit of allowable capacity while GC is the minimum guaranteed capacity. The scheduler may allocate more capacity than GC depending on availability of uplink capacity.

An implementation of FCC for GBR traffic class is illustrated in Fig. 4. The QoS parameters of GBR traffic class are the Maximum Capacity (MC) and Guaranteed Capacity (GC). Retransmission data has a higher priority than new transmission so AC is firstly allocated to retransmission data and the remaining capacity is then allocated to new transmission data [41 and 42]. For the allocation of new transmission, a QoS parameter of Maximum Capacity is used as an upper-limit whereas the lower limit is either current flow queue size (QC) or available capacity for new transmission (NDC). It is clear that the LOC is positive in only when NDC is larger than MC or QC is smaller than NDC. Finally a calculation of Capacity Request (CR) is carried out by comparisons between Maximum Capacity (MC) and residual flow queue size (QC-ACNT) (43 in Fig. 4).

ABR is a traffic class of which capacity is maintained depending on the availability of capacity. The QoS parameters of ABR traffic class are the Maximum Capacity (MC) and Minimum Capacity (MNC). MC is the upper limit of allowable capacity while MNC is the minimum capacity to support timely transmission of small data packets such as TCP ACK.

An implementation of ABR FCC is equal to GBR FCC by setting the QoS parameter of guaranteed capacity (GC) equal to zero. In this case, there is no QoS requirement for the Capacity Scheduler so that it can allocate as much capacity as available. Preferably, CS allocates at least a MNC for timely transmission of small data packets.

TBR is a traffic class of which capacity is maintained at a target level. The QoS parameters of TBR traffic class are the Maximum Capacity (MC) and Target Capacity (TC). MC is the upper limit of allowable capacity while FCC controls an instantaneous capacity in order to make an average capacity equal to TC.

An implementation of TBR FCC is shown in Fig. 5. Retransmission data has a higher priority than new transmission so AC is firstly allocated to retransmission data and the remaining capacity is then allocated to new transmission data (51 in Fig. 5). For the allocation of new transmission, firstly a gap is calculated between a current moving average of allocated capacity (MAAC) and the TC (52). Then, a required capacity to meet TC criteria is calculated using an adjustment (53 and 530). Then, capacity allocation is performed in such a way that the allocated capacity (ACNT) does not exceed both MC and queue size (QC) 54. The MAAC is updated with moving average using newly calculated ACNT (55) and finally Capacity Request (CR) is calculated in order to achieve TC asymptotically(56). In order to speed up the convergence rate, exponential type of adjustment function can be used(530).

An implementation of uplink capacity scheduler is shown in Fig. 6. At the beginning of scheduling interval, the base station measures the non-schedulable uplink capacity including component of the thermal noise, inter-cell interference and non-schedulable data transmission 601 in Fig. 6. The non-schedulable data transmission is a background load over which the scheduler has no control. Then CS calculates the available schedulable capacity as a difference between a maximum and the non-schedulable capacity.

Receiving upon the Capacity Request from mobile stations, the base station performs an adjustment of Capacity Request in what follows 602

in Fig. 6: The base station calculates a maximum supportable capacity for each mobile station after assigning minimum allowed transmission power headroom for each mobile station. The minimum transmission headroom controls the amount of interference to other cells in the network. The maximum supportable capacity at given minimum transmission headroom is compared with the total amount of required capacities. In order to meet the maximum supportable capacity to be larger than the total amount, the excessive QoS portion of the Capacity Request is reduced from the lowest to highest priority flow. If not sufficient, the minimum QoS portion of the Capacity Request is reduced from the lowest to highest priority flow; If not sufficient, the retransmission portion of the required capacity is reduced from the lowest to highest priority flow. The base station calculates the total amount of required retransmission capacity (RCRTX), minimum QoS capacity for each priority level (RCMQ(1),...,RCMQ(N)), excessive QoS capacity (RCEQ(1),...,RCEQ(N)) for all mobile stations. The base station also calculates, for each flow of each mobile station, a retransmission capacity, a minimum QoS and a excessive QoS capacity using the flow information and reported Capacity Request.

In order to maintain a total assigned capacity to be smaller than the total schedulable capacity, the base station assigns firstly the schedulable capacity to the retransmission capacity 61 in Fig. 6. If not sufficient for the total amount of required retransmission capacity, then the base station allocates retransmission capacity from highest to lowest flow. If sufficient, the base station assigns the remaining schedulable capacity to the minimum QoS capacity starting from flows in the highest priority 62 in Fig. 6 to the lowest priority 63 in Fig. 6. If sufficient, the base station assigns the remaining schedulable capacity to the excessive QoS capacity starting from flows in the highest priority 64 in Fig. 6 to the lowest priority 65 in Fig. 6. Between flows belong to the same priority level, the capacity is distributed, preferably, in a fair scheduling manner. Finally the base station calculates a total assigned capacity, for each flow of each

mobile station, as a sum of assigned retransmission capacity, assigned minimum QoS and assigned excessive QoS capacity.

3. Brief Description of Drawings

Fig.1 illustrates communication between base station and a mobile station, the uplink capacity being controlled by scheduler taking into account of QoS of data flows.

Fig. 2 is a general schematic illustration of capacity scheduling for support of multiple QoS traffic class and priority handling.

Fig.3 is a flowchart explaining a general Flow Capacity Controller.

Fig. 4 is a flowchart of Flow Capacity Controller for GBR traffic class.

Fig. 5 is a flowchart of Flow Capacity Controller for TBR traffic class.

Fig. 6 is a general flowchart illustration of Capacity Scheduler in which hierarchical capacity allocation is explained to support the multiple QoS and multiple priority flows.

【Reference Numerals】

11: Mobile Station 1

12: Mobile Station 2

13: Capacity Scheduler at the base station

14: Capacity Scheduling

211: Flow Queue at mobile station

212: FCC (Flow Capacity Controller)

213: CRC (Capacity Request Controller)

2130: PHR (transmission Power Headroom)

214: CAC (Capacity Assignment Controller)

215: TFCC (Transport Format Combination Controller)

216: ENC (Encoder)

217: FMUX (Flow Multiplexer)

221: FDEMUX (Flow De-multiplexer)

222: DEC (Decoder)

223: Flow Queue at base station

224: RETTX (Retransmission Controller)

225: CS (Capacity Scheduler)

226: Received Capacity Request

227: Capacity Assignment

241: UL-CCH (Uplink Control Channel)

242: DL-CCH (Downlink Control Channel)

243: UL-DCH (Uplink Data Channel)

310: AC (Assigned Capacity)

33: ACRT (Allocated Capacity for Retransmission)

35: ACNT (Allocated Capacity for New Transmission)

36: CR (Capacity Request)

360: LOC (Left Over Capacity)

41: NDC (New Data Capacity), AVC (Currently Available Capacity for the flow), RCR (Required Capacity for Retransmission)

42: ACRT (Allocated Capacity for Retransmission), ACNT (Allocated Capacity for New Transmission), QC (Current Queue Buffer Size), MC (Maximum Capacity)

43: CR (Capacity Request)

51: NDC (New Data Capacity), AVC (Currently Available Capacity for the flow), RCR (Required Capacity for Retransmission), ACRT (Allocated Capacity for Retransmission)

52: TC (Target Capacity), MAAC (Moving Average of instantaneous Capacity)

53: RC (Required Capacity to achieve TC), MC (Maximum Capacity)

530: Adj(x) (Adjustment function), Madj (Maximum Adjustment)

54: ACNT (Allocated Capacity for New Transmission), QC (Current Queue Buffer Size)

55: Moving Average function (MA(x,d,a) where $x(n) = a*x(n-1) + (1-a)*d$), alpha (moving average coefficient)

56: CR (Capacity Request)

610: Capacity allocated for retransmission

620: Capacity allocated for Minimum QoS Capacity of 1st highest ordered set

640: Capacity allocated for available capacity of 1st highest ordered set.

ABR: Available Bit Rate

BE: Best Effort

CR: uplink Capacity Request

CA: uplink Capacity Assignment

GBR: Guaranteed Bit Rate

TBR: Target Bit Rate

QoS: Quality of Service

RNC: Radio Network Controller

WCDMA: Wideband Code Division Multiplexing

【書類名】外国語図面

F I G. 1

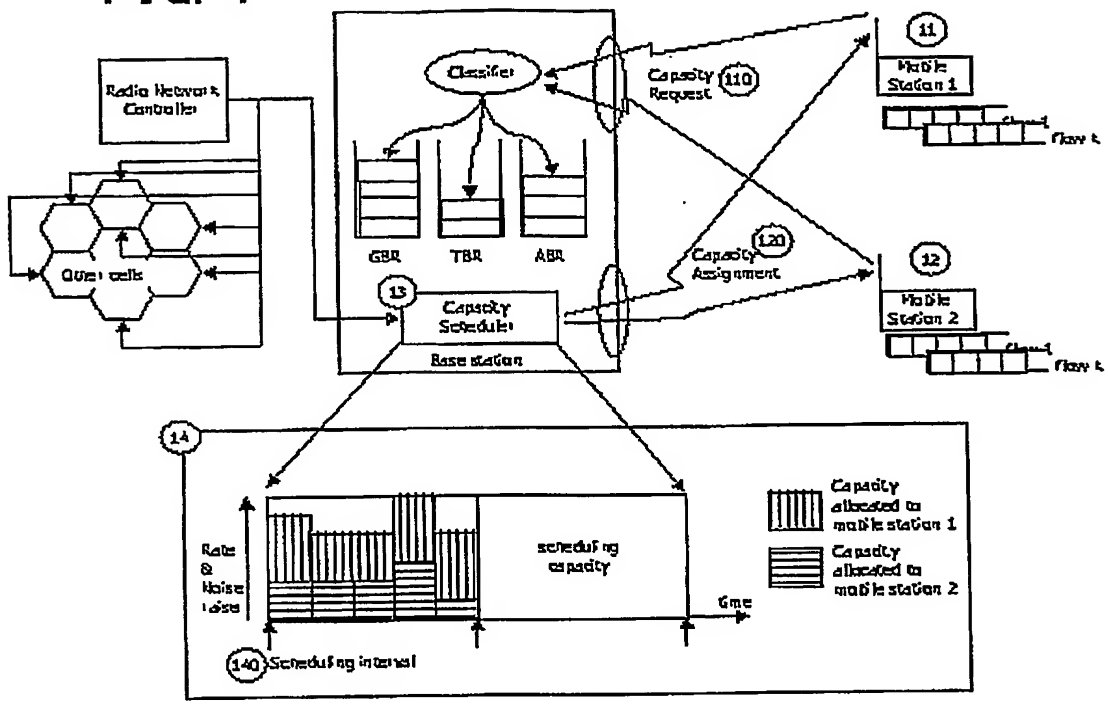


FIG. 2

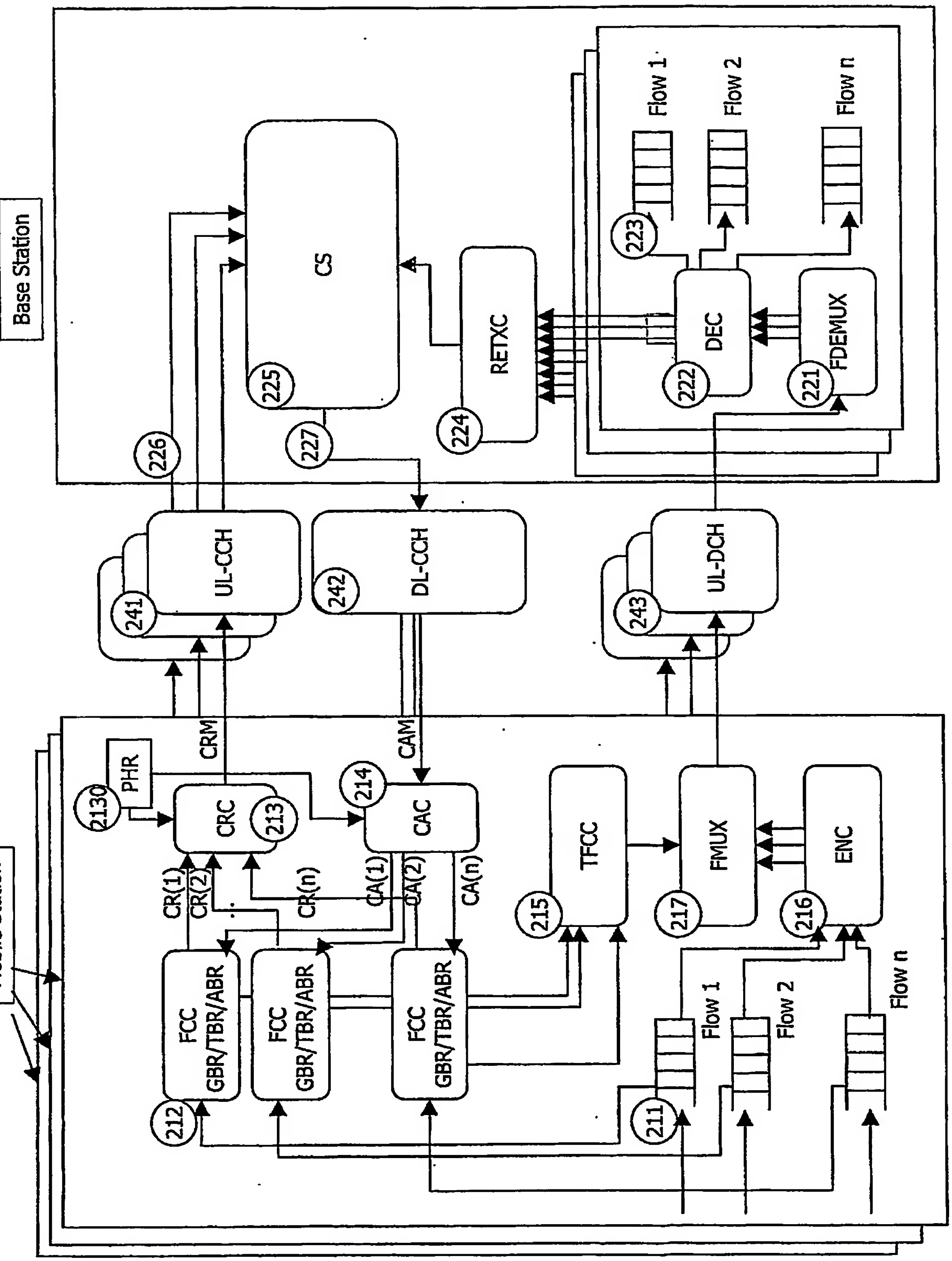

Base Station
Mobile Station
CS
225
226
227
RETXC
224
DEC
222
FDEMUX
221
223
Flow 1
Flow 2
Flow n
UL-CCH
241
DL-CCH
242
UL-DCH
243
CRM
CAM
PHR
2130
CRC
213
CAC
214
CR(1)
CR(2)
CR(n)
CA(1)
CA(2)
CA(n)
TFCC
215
FMUX
217
ENC
216
FCC
GBR/TBR/ABR
212
211

FIG. 3

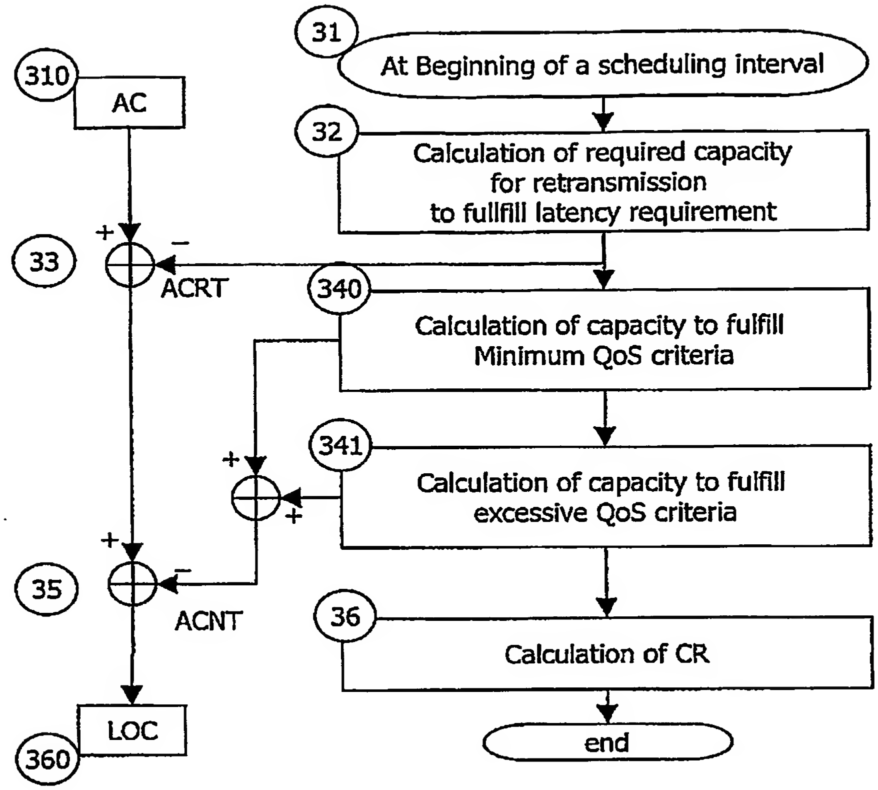


FIG. 4

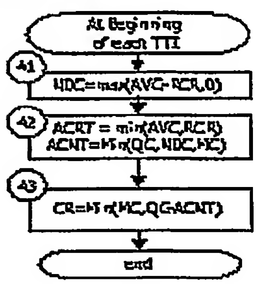


FIG. 5

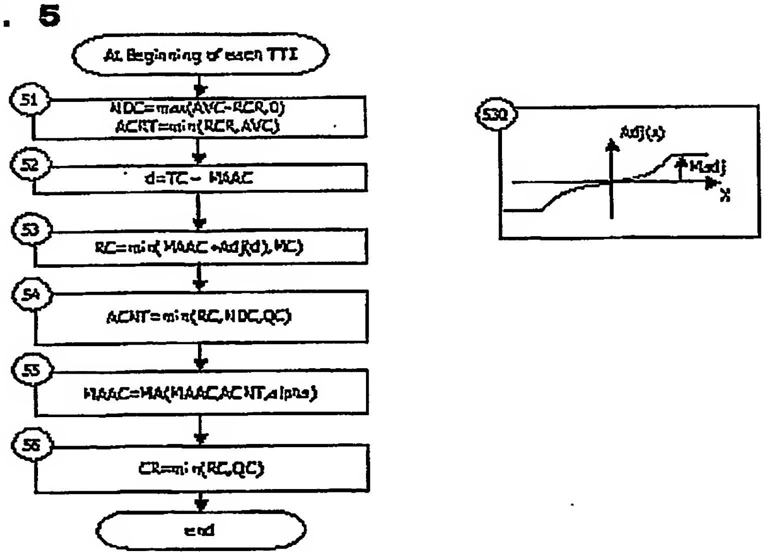
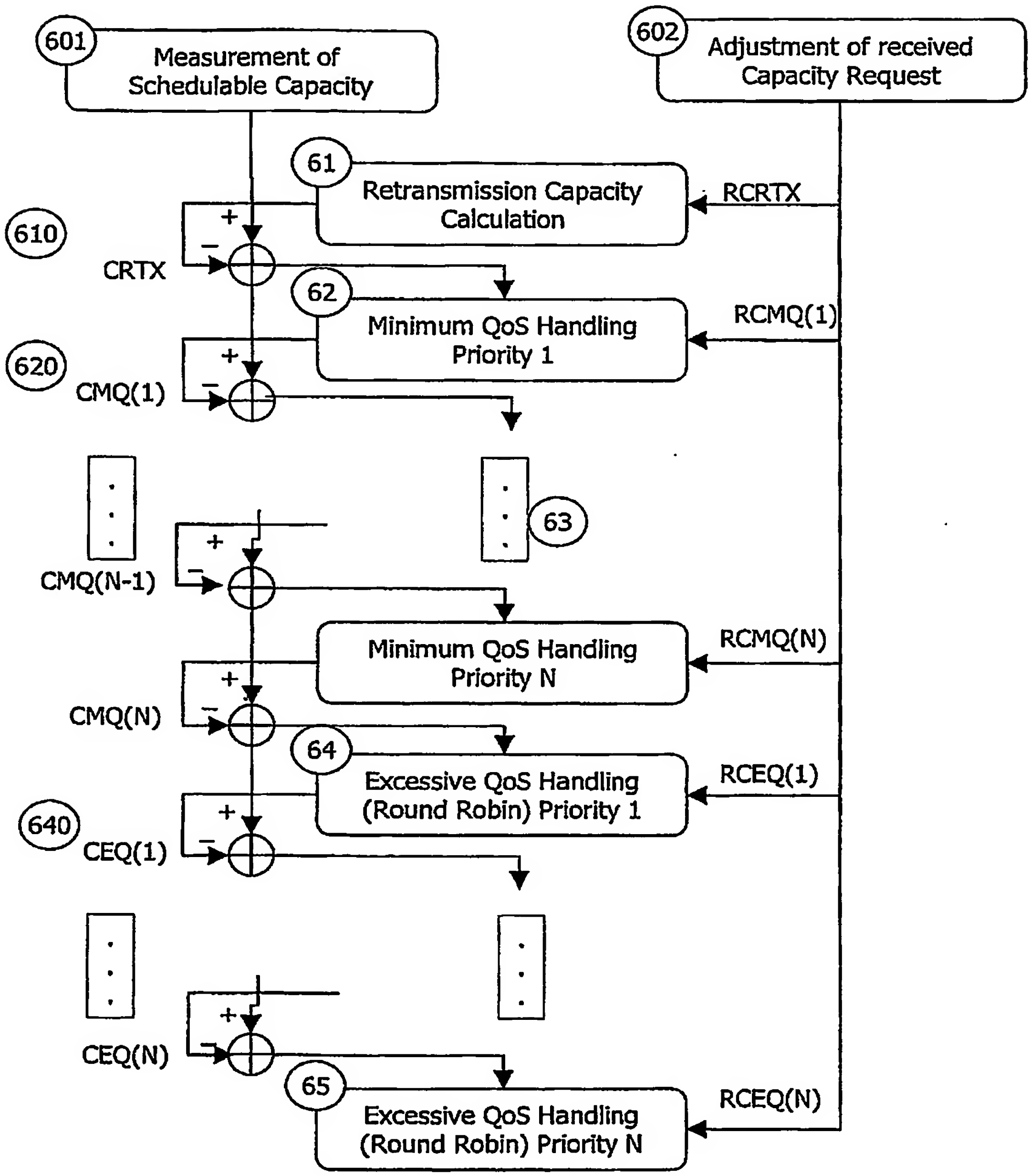


FIG. 6


601
Measurement of Schedulable Capacity
602
Adjustment of received Capacity Request
61
Retransmission Capacity Calculation
RCRTX
610
CRTX
62
Minimum QoS Handling Priority 1
RCMQ(1)
620
CMQ(1)
63
CMQ(N-1)
Minimum QoS Handling Priority N
RCMQ(N)
CMQ(N)
64
Excessive QoS Handling (Round Robin) Priority 1
RCEQ(1)
640
CEQ(1)
CEQ(N)
65
Excessive QoS Handling (Round Robin) Priority N
RCEQ(N)

【書類名】外国語要約書

1. Abstract

In a system having a base station and a mobile station, no consideration is made about the mobile station which can carry out communication of different QoS traffic classes with the base station. A flow capacity controller (FCC) is included in each mobile station to calculate an uplink capacity of a data flow with reference to QoS and priorities while a capacity request controller (CRC) modifies capacity requests of data flows in consideration of the calculated QoS and priorities. A capacity scheduler (CS) is included in a base station to calculate an allowable capacity in response to the capacity requests and to transmit a capacity assignment from the base station to each mobile station. With this structure, the mobile station can be operated in accordance with a plurality of QoS traffic classes.

2. Representative Drawing

Fig. 2

特願２００３－３５６９３６

出　願　人　履　歴　情　報

識別番号　　　　　［０００００４２３７］

１．変更年月日　　１９９０年　８月２９日
　　［変更理由］　新規登録
　　　住　所　　東京都港区芝五丁目７番１号
　　　氏　名　　日本電気株式会社